

Management Recommendations for
***Bryoria spiralifera* Brodo & D. Hawksw.**

version 2.0

CONTENTS

SUMMARY	1
I. Natural History	2
A. Taxonomy and Nomenclature	2
B. Species Description	2
1. Morphology and Chemistry	2
2. Reproductive Biology	4
3. Ecological Roles	4
C. Range and Known Sites	5
D. Habitat Characteristics and Species Abundance	5
II. Current Species Situation	6
A. Why Species Is Listed Under Survey and Manage Standard and Guideline	6
B. Major Habitat and Viability Considerations	6
C. Threats to the Species	7
D. Distribution Relative to Land Allocations	8
III. Management Goal and Objectives	8
A. Management Goal for the Species	8
B. Objectives	8
IV. Habitat Management	8
A. Lessons From History	8
B. Identifying Habitat Areas for Management	9
C. Managing in Habitat Areas	9
D. Other Management Issues and Considerations	10
V. Research, Inventory, and Monitoring Needs	10
A. Data Gaps and Information Needs	10
B. Research Questions	10
C. Monitoring Needs and Recommendations	10
REFERENCES	11

SUMMARY

Species: *Bryoria spiralifera* Brodo & D. Hawksw

Taxonomic Group: Lichens (Rare Oceanic Influenced)

ROD Components: 1, 3

Other Management Status: Oregon Natural Heritage Program List 2 (taxa that are threatened with extirpation or presumed to be extirpated from the state of Oregon); Natural Heritage Networks Rank: Global Rank G2? (rank of G2 is uncertain, but is defined as imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences), State Rank S1 (critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences) (Oregon Natural Heritage Program 1998), and BLM Assessment Status (USDI Bureau of Land Management 1998).

Range: *Bryoria spiralifera* is a rare lichen, endemic to coastal California and Oregon. In California, it is known from Humboldt County (Samoa Peninsula, Patricks Point State Park, Humboldt Lagoons State Park, Cove State Beach), Monterey County (Point Lobos), Sonoma County (Stewart's Point Road), and San Luis Obispo County (Baywood Park). In Oregon, it occurs on the Siuslaw National Forest near Bluebill Lake and near Spin Reel Campground.

Specific Habitat: *Bryoria spiralifera* grows on exposed trees (especially Sitka spruce and shore pine) and shrubs on forested, coastal, windswept dunes and headlands at or near sea level within 3 km (1-2 mi) of the ocean. Frequent fog, and various ocean-influenced climatic, vegetative and edaphic factors appear to be important factors influencing the distribution of this species, which appears to have a narrow ecological amplitude.

Threats: The main threats are activities that directly harm the populations, their habitat, or the potential habitat surrounding populations. Examples of threats include: trampling from recreational activities; harvesting trees; constructing roads, trails or buildings; invasive exotic plants; burning (in some places); grazing; changes in local hydrology; and air pollution.

Management Recommendations:

- Manage known sites to maintain local populations and their habitat area.
- Develop practices to route human use away from known sites.
- Manage fire in the habitat areas, with emphasis on prevention.
- Restrict removal of trees, shrubs, or other vegetation from the known sites and habitat areas, except when removal will not harm habitat integrity.

Information Needs:

- Visit known sites to determine the extent of local populations and improve habitat descriptions.
- Determine if this species is closely associated with late-successional and old-growth forests.
- Determine if additional populations exist in areas identified as potential suitable habitat.

Management Recommendations for *Bryoria spiralifera*

I. NATURAL HISTORY

A. Taxonomy and Nomenclature

Bryoria spiralifera Brodo & D. Hawksw. was described in 1977 (Brodo and Hawksworth 1977) and has no synonyms. It was placed in the *Implexae* section of *Bryoria*, which includes *B. capillaris*, *B. friabilis*, *B. implexa*, *B. nadvornikiana*, *B. pikei*, *B. pseudocapillaris*, *B. pseudofuscescens*, and *B. salazinica*. The section is characterized by the occurrence of b-orcinol depsidones other than fumarprotocetraric acid, small pseudocyphellae and a characteristic cortical structure that tends to make the branches more friable than usual. Because of their unusual pseudocyphellae, both *B. spiralifera* and *B. pseudocapillaris* were placed in this group with some hesitation. The distinctively depressed pseudocyphellae and pale brown to chestnut color of both species are closer to the chemically similar genus *Sulcaria*. The two species may actually have an intermediate taxonomic standing between the *Bryoria* section *Implexae* and the genus *Sulcaria*. In addition, similarities in branching type, color, and ecology between *B. spiralifera* and *B. pseudocapillaris* indicate they are particularly closely related.

B. Species Description

1. Morphology and Chemistry

Bryoria spiralifera is a dark to pale reddish-brown, filamentous, epiphytic lichen (Figure 1). It has a short, pendent thallus, 6-7 cm long with conspicuous, long (up to 4 mm), white, linear, sometimes furrowed pseudocyphellae, most of which are twisted in long spirals around the branches. Other distinctive features are the numerous short, slender perpendicular branches, paler than the main branches. The main branches are 0.2-0.25 mm in diameter, uneven in cross section, and straight to twisted. The branching pattern is isotomic dichotomous at the base, with main branches becoming anisotomic dichotomous. True lateral spinules, isidia, and soralia are absent. Apothecia and pycnidia are unknown. The cortex is K+ red, C-, KC+ red, PD+ yellow; the medulla is K-, C-, KC-, and PD-. This lichen contains large amounts of norstictic acid, together with smaller quantities of connorstictic acid and atranorin (Brodo and Hawksworth 1977).

Bryoria spiralifera can be confused with other chestnut-colored coastal treehair lichens. *Bryoria pseudocapillaris*, for example, shares the same habitat. Although similar in appearance, the two species have a very different chemistry. *Bryoria pseudocapillaris* contains only alectorialic and barbatolic acids, and the cortex is K+ yellow, C+ pink, and KC+ pink. It also has somewhat shorter (up to 3 mm) pseudocyphellae than does *B. spiralifera*, and they are mainly straight rather than spiraling. The unique deep, longitudinal sulcae (grooves or fissures) of *Sulcaria badia* easily distinguish it from *B. spiralifera*. *Nodobryoria oregana* is the most common reddish-colored *Bryoria* of the Coast Range and has short perpendicular side branches, but it

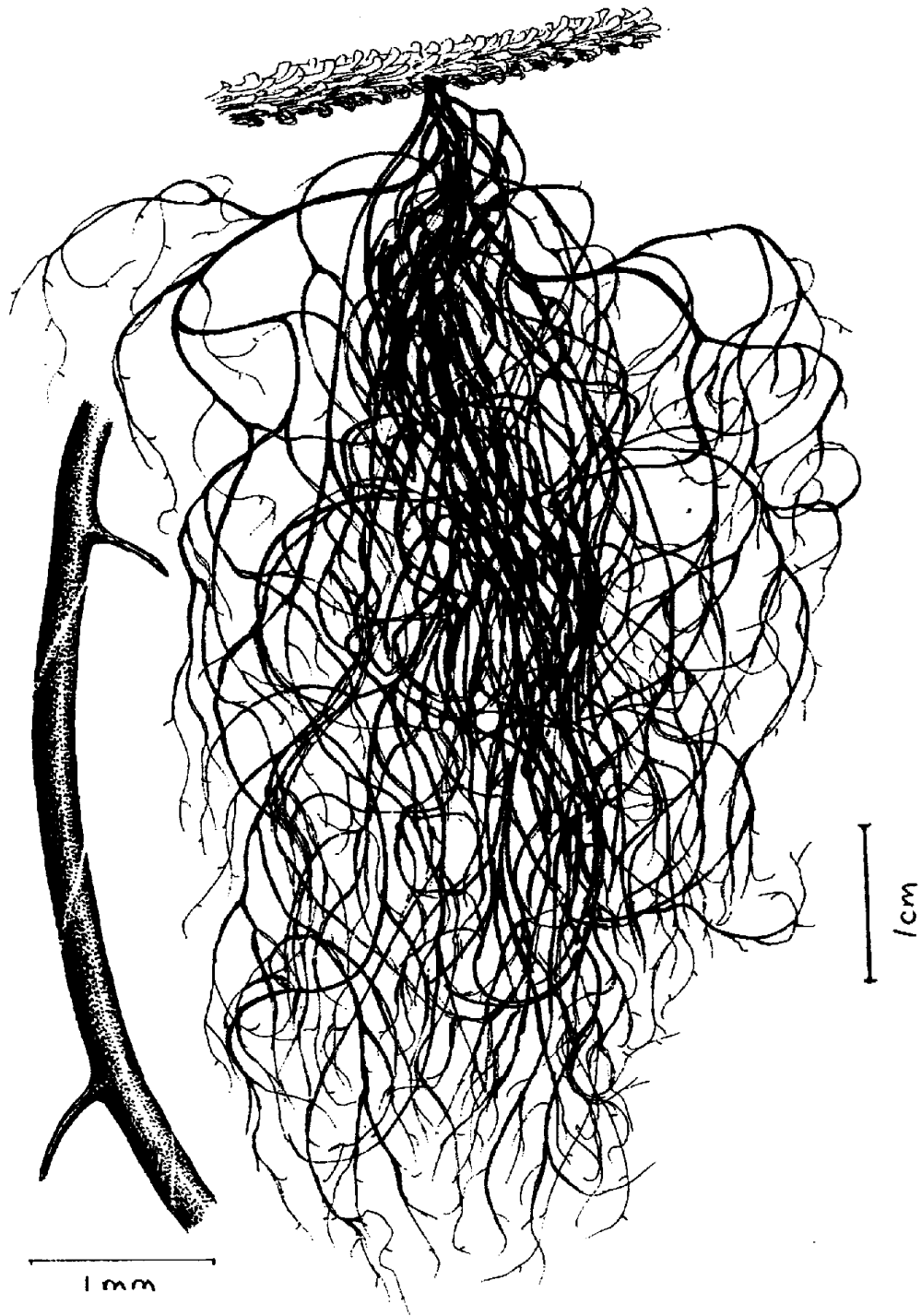


Figure 1. Line drawing of *Bryoria spiralis* by Alexander Mikulin.

lacks pseudocyphellae, usually has apothecia, and--because it contains no lichen substances--is K-, C-, KC-, and PD-.

Pale individuals of *B. spiralifera* can be confused with other pale coastal tree hair lichens:

- *Bryoria capillaris* is the most common pale brown to pale grayish *Bryoria* in the Coast Range. Although they both contain alectorialic and barbatolic acids and have the same reaction to chemical spot tests, *B. capillaris* lacks the frequent short side branches typical of *B. spiralifera* and has short, inconspicuous (as opposed to long, white, conspicuous) pseudocyphellae. The two species also differ in habitat: *B. capillaris* is primarily a lichen of sheltered forests, but *B. spiralifera* grows in exposed sites along the immediate coast (McCune *et al.* 1997).
- *Bryoria trichodes* ssp. *trichodes* is easily distinguished from *B. spiralifera* by its K-, C- and KC- spot tests. In addition, the medulla is usually P+ red (contains fumarprotocetraric acid), as opposed to P+ deep yellow (Brodo and Hawksworth 1977).
- *Bryoria subcana* has abundant, conspicuous, white soralia but soralia are never present in *B. spiralifera*.
- *Bryoria friabilis* has long, spiraling pseudocyphellae, but its K-, P-, and KC+ pinkish-orange reactions and uneven, wrinkled branches, readily distinguish it.
- *Bryoria pseudofuscescens* has short, inconspicuous pseudocyphellae and is KC-.
- *Bryoria pseudocapillaris* (see discussion above).

2. Reproductive Biology

Bryoria spiralifera reproduces asexually by thallus fragmentation. Smaller asexual propagules containing both fungal and algal partners (for example, soredia or isidioid spinules) are absent for this species, and sexual reproductive structures (fungal apothecia) have never been observed (Brodo and Hawksworth 1977).

Like other pendent lichens in the genera *Alectoria*, *Bryoria* and *Usnea* that reproduce by thallus fragmentation (Esseen *et al.* 1981, Stevenson 1988, Dettki 1998), *Bryoria spiralifera* reproduces effectively over short distances (within a few hundred meters) but is may be dispersal limited over long distances. Many lichens produce microscopic sexual and asexual propagules that are dispersed long distances by wind, animals, or birds (Bailey 1976). The thallus fragments of *Bryoria spiralifera* are less likely to be carried as far by wind or animal vectors. Because the habitat is rare, even propagules which are transported across long distances are unlikely to encounter conditions suitable for establishment. In addition, because current populations are widely separated, and because *B. spiralifera* apparently lacks the means for sexual reproduction, genetic diversity within populations may be low and exchange of genetic material between populations may be absent.

3. Ecological Roles

Little is known about the ecological roles of *Bryoria spiralifera*. Other *Bryoria* species provide forage and nesting material for a variety of animal species such as insects, birds, small

mammals, and ungulates (McCune and Geiser 1997). The Samoa Peninsula is home to the largest population of *Bryoria spiralifera*. Because the lichen can be found abundantly draped over trees in many places, it is probable that some animals utilize it.

C. Range and Known Sites

The current world-wide distribution of *Bryoria spiralifera* consists of nine known sites. *Bryoria spiralifera* is limited to a very few widely spaced populations, in exposed sites within 3 km (1-2 mi) of the California and Oregon coasts. Three known sites occur on federal land within the range of the Northwest Forest Plan: the Samoa Peninsula; Bluebill Lake vicinity, Siuslaw National Forest (Coos County, Oregon) (McCune 23696, 23700); and Spin Reel Campground vicinity in the Oregon Dunes National Recreation Area (Coos County).

Bryoria spiralifera was described from a single location: the 15 km (9 mi) long, 1 km (0.6 mi) wide, Samoa Peninsula near Eureka and Arcata (Humboldt County, California) (Brodo and Hawksworth 1977). Current information suggests that this lichen is both rare and limited to the immediate coast as extensive surveys conducted by the Forest Service on seven national forests, in over 1200 locations, located only the one site near Spin Reel Campground (USDA 1998).

Non-federally managed sites for *B. spiralifera* include Patricks Point State Park, Humboldt Lagoons State Park, and College Cove State Beach (all in Humboldt County, California) (Glavich, pers. comm.). Riefner *et al.* (1995) reported three other California sites: Stewart's Point Road (Sonoma County), Baywood Park (San Luis Obispo County) and the Point Lobos vicinity (Monterey County). The latter two locations are outside the range of the Northwest Forest Plan.

D. Habitat Characteristics and Species Abundance

Bryoria spiralifera is a lichen of very narrow ecological amplitude. It grows on exposed or moderately exposed coastal trees, snags and shrubs, in forests or woodlands of windswept dunes and headlands. All known sites are at or near sea level (< 50 m (165 ft) elevation) and within 3 km (1-2 miles) of the ocean. *Bryoria spiralifera* is found predominantly on shore pine (*Pinus contorta*) and Sitka spruce (*Picea sitchensis*) but is also found on grand fir (*Abies grandis*), evergreen huckleberry (*Vaccinium ovatum*), chaparral broom (*Baccharis pilularis*) and, occasionally on red alder (*Alnus rubra*) and willow species (*Salix* spp.) (Glavich, pers. comm.). On the Samoa Peninsula, it is frequently mixed with the draping, epiphytic lichen, *Ramalina menziesii* (Brodo and Hawksworth 1977). It is known to be scattered but locally abundant near Blue Gill Lake and on the Samoa Peninsula.

The following coastal plant communities, described by Christy *et al.* (1998), are preferred habitat for *Bryoria spiralifera*: Sitka Spruce/Evergreen Huckleberry forest, Sitka Spruce-Shore Pine/Evergreen Huckleberry forest, Shore Pine/Hairy Manzanita (*Arctostaphylos columbiana*) woodland, and Shore Pine/Bearberry (*Arctostaphylos uva-ursi*) woodland. The largest population of *B. spiralifera* occurs on the Samoa Peninsula, where it achieves its highest density on the exposed branches in the canopy and on the edge of the moving dunes, especially on the

oldest trees. Some of the old snags of shore pine and Sitka spruce, partially buried at the apex of a moving dune, support the largest, most well-established thalli (Glavich, pers. comm.). It also occurs in the canopy and edges of Sitka spruce-shore pine forests with thick to impenetrable understories of evergreen huckleberry, typical of dry stabilized dunes, tree islands, and deflation planes. It is also found in open shore pine woodlands with an understory of bearberry and mats of the reindeer lichen *Cladonia*.

Although many of the habitat areas are not climax communities, *Bryoria spiralifera* typically occupies older substrates within those communities. At the Lanphere Dunes Unit (Humboldt Bay National Wildlife Refuge, USFWS) on the Samoa Peninsula the oldest shore pine are approximately 150 years old (Glavich, pers. comm.). Mature shore pine in shore pine/bearberry woodlands at the Oregon Dunes National Recreation Area average between 80 to 130 years old. Sitka Spruce/Evergreen Huckleberry forests are mid-seral to climax communities and can contain Sitka spruce that are many centuries old (Christy *et al.* 1998).

II. CURRENT SPECIES SITUATION

A. Why Species is Listed Under Survey and Manage Standard and Guideline

Bryoria spiralifera was considered at risk under the Northwest Forest Plan because it was thought to be a very rare lichen with a limited distribution (USDA and USDI 1994a, 1994b). At the time, it was known from one population world-wide (USDA and USDI 1994a, 1994b). The viability ratings reflected a high level of concern for this species. The rare oceanic-influenced lichens as a group received the lowest viability ratings among all the lichens considered (USDA and USDI 1994a).

Because of the low viability ratings and high level of concern, this species was identified as a Survey and Manage strategy 1 and 3 species (USDA and USDI 1994c), with the dual objectives of managing known sites, and conducting extensive surveys to locate additional populations and identify other high-priority sites for species management.

B. Major Habitat and Viability Considerations

The major concerns for *Bryoria spiralifera* are the small number of known populations, limited amount of suitable habitat for this species on federal land, and loss of populations from management or recreational activities that damage the populations or the remaining habitat. Climate change or air pollution could also cause a decline in vigor of this species or contribute to extirpation of local populations.

Because of the small number of known sites world-wide, *B. spiralifera* is one of the most threatened species on the survey and manage list of the Northwest Forest Plan. Discovering or establishing additional populations would lower concerns about its viability.

The persistence of this lichen is very uncertain because of the limited potential for federal

management along the immediate coast and the very few known sites. The main population stronghold is the Samoa Peninsula, much of which is under private ownership. Timber harvest, expansion of the area open to recreational activities, or additional development could further restrict its habitat on the Samoa Peninsula, and elsewhere along the coast.

For species with inefficient means for long-distance dispersal, isolation of populations also leads to genetic isolation. Almost nothing is known about the genetics of lichen populations or the effects of gene pool isolation on local extinction rates of populations.

C. Threats to the Species

Threats to *B. spiralifera* are those actions that disrupt stand conditions necessary for its survival. Such actions include treatments that reduce local populations by removing colonized bark or wood substrates; decreasing exposure to light; adversely affecting integrity of habitat areas; reducing or fragmenting potential habitat; or degrading air quality.

Recreational activities and developments may inadvertently alter the habitat of this species. Trampling by recreational vehicles and frequent foot traffic are serious threats, especially in shore pine woodlands and edge communities, as these degrade the habitat by disturbing fragile root systems of trees and shrubs, and the fragile protective mats of ground cryptogams, which stabilize the soil (Christy *et al.* 1998). Destabilization of the foredunes by recreationists or removal of European beachgrass (*Ammophila arenaria*) can destabilize tree island habitats of *B. spiralifera* by increasing the amount of sand drift into them and burying trees on the perimeter (Christy *et al.* 1998). Buildings, roads, campgrounds and trails along the immediate coast have replaced many natural habitats to improve access, facilitate scenic views, or develop recreational uses.

Other threats to the integrity of habitat and potential habitat areas include logging, grazing, agriculture, and activities which alter local hydrology, or increase fire frequency (Christy *et al.* 1998). Concern about fire varies--many different plant communities and successional stages exist among the coastal dunes and headlands; fire is beneficial to some communities but damaging to others. Invasion or planting of exotics such as Scots broom (*Cytisus scoparium*), European beachgrass, tree lupine (*Lupinus arboreus*), birdsfoot-trefoil (*Lotus corniculatus*), and iceplant (*Mesembryanthemum* spp.) can have profound effects on nitrogen-poor dune soils by increasing nitrogen and soil moisture. These conditions foster invasion of other weeds, eventually disrupting native plant communities (Christy *et al.* 1998) and reducing plant and animal diversity (USDI 1997).

Although the air-pollution sensitivity of this species is unknown, other coastal members of this genus are sensitive to sulfur- and nitrogen-based acidifying pollutants (Wetmore 1983, Insarova *et al.* 1992, McCune and Geiser 1997). Because the primary habitat of this lichen is the coastal fog belt, and because fog significantly concentrates pollutants--especially acidic forms of SO_x and NO_x to which lichens are most sensitive--the potential vulnerability of *B. spiralifera* to air-quality deterioration is a reasonable concern. Although air quality is generally good at known sites, rising pollution emissions from increased traffic (mainly NO_x) and new or expanded point

sources (SO_x and NO_x) in the Arcata/Eureka vicinity, and elsewhere along the coast, might threaten this species in the future.

Climate change affecting coastal fog patterns could be expected to affect the vigor of this species, possibly resulting in an even more restricted distribution or contributing to local extirpation.

D. Distribution Relative to Land Allocations

The population at Bluebill Lake is on a parcel of land administered by the Siuslaw National Forest, bordering the southern edge of the Oregon Dunes National Recreation Area. Although not Congressionally withdrawn, part of the area occupied by the population is managed for wildlife and plant viewing and part is an undeveloped area off-limits to motor vehicles. The population near Spin Reel Campground may be inside the Oregon Dunes National Recreation area, and Congressionally withdrawn, or just outside. Most of the Samoa Peninsula is privately owned, but the US Fish and Wildlife Service manages the Lanphere Dunes Unit (USDI 1997) and there are several parcels of land managed by the BLM. Patricks Point, Humboldt Lagoons, and College Cove are state parks of California.

III. MANAGEMENT GOAL AND OBJECTIVES

A. Management Goal for the Species

The goal for managing *B. spiralifera* is to assist in maintaining species viability.

B. Objectives

Manage populations at all known sites on federal land by maintaining habitat and potential habitat immediately surrounding known populations.

IV. HABITAT MANAGEMENT

A. Lessons From History

Habitat destruction or alteration has made a significant contribution to the decline of lichens world-wide (Seaward 1977). Rare lichens that are limited to habitats optimal for human activities, such as *Bryoria spiralifera*, are especially vulnerable. At the northern Samoa Peninsula, on county and state land near the mouth of the Little River, the native dune communities have been nearly eliminated by the invasion of European beachgrass and human activities, and only a tiny fragment of the dune forest remains. Lichens are also absent from the southern end of the Peninsula's dune forest, where the trees are young and there is more off-road vehicle evidence (Glavich, pers. comm.). At the Lanphere Dunes Unit, even hiking has been documented to damage fragile shore pine/bearberry (*Arctostaphylos uva-ursi*) communities

(Brown 1990). In coastal Oregon, activities of the past 140 years: increased fire, agriculture and grazing, logging, changes in hydrology and recreation have affected plant succession in a major way (Christy *et al.* 1998). At Sand Lake dunes of Oregon, a hotspot for lichen diversity, off-road vehicles have destroyed nearly all the shore pine woodlands in just thirty years (Wiedemann 1984, 1990 as cited by Christy *et al.* 1998).

Lichens have been known to be sensitive to air pollution more than a century. Populations of many species in eastern United States and Europe (Hawksworth and Rose 1976) have declined precipitously from exposure to sulfur dioxide and other air pollutants. In the United States, lichens are one of the components used to indicate stress to forests from air pollution (McCune *et al.* 1996), and dozens of studies in the United States have used lichens as air-quality indicators (see bibliography in USDA 1998). In the Pacific Northwest, sensitive species are already declining in some areas (Denison and Carpenter 1973, Taylor and Bell 1983) and lichens are identified as Air Quality Related Values in USDA Forest Service air resource management regional guidelines (Peterson *et al.* 1992).

B. Identifying Habitat Areas for Management

All known sites of *B. spiralifera* on federal land administered by the Forest Service and BLM in the range of the Northwest Forest Plan are identified as habitat areas where these management recommendations should be implemented. A habitat area for management is defined as suitable habitat occupied by or near a known population.

C. Managing in Habitat Areas

The objective of managing in habitat areas is to maintain the habitat conditions for *B. spiralifera*. Specific recommendations are to:

- Determine the extent of the local population and habitat area with a site visit.
- Maintain suitable habitat around the current host trees and shrubs, so that the lichen may have adequate new substrate as current substrates decline.
- Develop practices to route human use away from the populations in habitat areas (for example, divert roads, trails and off-road vehicles). Trampling shrubs or cryptogam mats, compacting roots, damaging trees or branches that serve as substrates, introducing non-native species by seed dispersal or planting, can all adversely affect habitat integrity.
- Avoid harvesting trees, shrubs, or other vegetation from the population and the habitat area unless these actions would do no harm to, or would improve, the habitat for *B. spiralifera* (for example, by preventing deeply shaded conditions or by removing invasive exotics).
- Prevent fire in the population but utilize or prevent fire in habitat areas, depending on the plant community, according to management guidelines suggested by Christy *et al.* (1998).
- Maintain integrity of the foredunes where they protect habitat areas.
- Restrict commercial collection of moss or fungi or other special forest products if these activities would adversely affect the integrity of habitat areas.

D. Other Management Issues and Considerations

- Consider opportunities for managing known sites during Forest Plan and Resource Management Plan revisions, such as Botanical Special Interest Areas, Areas of Critical Environmental Concern, or other administratively withdrawn designations, or by prescribing special standards and guidelines.
- Share information with state and private sectors to further activities directed at conserving *B. spiralifera*.
- Continue to work with state and federal regulatory agencies to protect air quality on federally-managed lands from on- or off-site emissions, especially of nitrogen- and sulfur-containing pollutants.
- Provide information about conserving rare lichens at visitor centers or other locations along the coast to build public support of conservation efforts and to discourage collection of specimens.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

The objective of this section is to identify opportunities to acquire additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Revisit known sites to verify the status of the species, determine the extent of local populations, and better characterize habitat conditions.
- Determine if *B. spiralifera* meets the criteria for being closely associated with late-successional and old-growth forests.
- Determine whether additional populations exist in areas identified as potentially suitable habitat, such as Gwynn Creek and Eel Creek on the Siuslaw National Forest; and inter-dune tree islands and scrub forests of the Oregon Dunes National Recreation Area; BLM parcels adjacent to Cape Lookout and other coastal BLM parcels.

B. Research Questions

- What are the dispersal rates and mechanisms of *B. spiralifera*?
- Which habitat and microclimate characteristics are necessary for establishing *B. spiralifera* thallus fragments and survival of established thalli?
- What is the genetic diversity of *B. spiralifera* within local populations and across the region?
- What is the air pollution sensitivity of *B. spiralifera*?
- What are the minimum and optimum patch sizes of colonized habitat necessary to provide for *B. spiralifera*?

- Can transplants be used to create local populations of *B. spiralifera* to increase its population base?

C. Monitoring Needs and Recommendations

- Monitor known sites for changes in microclimatic conditions, successional changes, and for inadvertent habitat damage from human activities or wildfire.
- Monitor dispersal and population trends of existing populations.
- Monitor air quality near key populations of *B. spiralifera* on federal lands (currently the Lanphere Dunes (USFWS) and the Siuslaw National Forest) and assess threats to this species.

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